

Strengthening a Region:

Using Input-Output Analysis to Quantify the Impact of Crop Diversity
on Maryland's Eastern Shore

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Executive Summary

The nine counties on Maryland's Eastern Shore are overwhelmingly rural and agricultural. Following the 2008 recession, most of these counties have seen less economic recovery than urban areas of Maryland.

Most farms in the region produce two or three crops in rotation – corn, soybeans, and wheat – marketed primarily as feed for national and international poultry integration firms. These firms are currently the foundation of the Eastern Shore's agricultural economy, and they are often the main source of private-sector employment, especially in the lower shore counties. However, this reliance on a small number of crops and firms exposes farmers and the region's economy to risk from domestic and global market forces, including price volatility and international currency manipulation. These and other forces have contributed to a loss of 21 percent of farmland on the Delmarva Peninsula since 1982.

We propose that investing in the diversification of agriculture could yield greater economic benefits than investment in the poultry industry alone. Specifically, vegetable farming may offer greater employment, more local spending and re-spending of personal income, and greater tax income for local governments.

The Farm Bureau estimates that if signed, the Trans-Pacific Partnership would bring \$13.6M of new sales to the Delmarva poultry industry. Using economic input-output analysis (IMPLAN), we modeled the effect of a \$13.6M increase to that industry. Then we used the expenditure pattern of a regional produce grower, aggregator, and distributor to model the same \$13.6M increase to the vegetable-farming sector.

In our models, vegetable farming produced more direct and induced jobs, and more local labor income, than the poultry industry; vegetable farming also yielded 16.5 percent more tax revenue to the region. Generally, local vegetable production generates a higher level of local spending and re-spending of wages within the region.



An ecological life cycle analysis also favored vegetable farm expansion over poultry farm expansion. Vegetable farming produced only half the greenhouse gases that poultry farming would, and poultry farming produced five times the amount of nitrogen pollution that vegetable farming released in the model. The relative impacts of grain/poultry and vegetable farming on water quality have not been assessed by the scientific community, nor have relative pesticide and herbicide use. However, a wide variety of studies show that greater crop diversity, in rotation, can improve soil health, increase crop resiliency, and reduce both petroleum and chemical inputs to farms, while simultaneously maintaining farm income.

For these reasons, our model encourages Maryland farmers to diversify their operations beyond supplying the conventional poultry industry. The use of small parcels of land to raise a variety of higher-market-value, vegetable crops for human consumption is a better use of the Eastern Shore's agricultural asset (natural capital) and proximity to large markets. Not only does it require less land; it produces less pollution, and generates higher economic returns for the local, rural communities. It will make farming more viable, keeping farmers on the land and preserving this region's beloved culture.

Introduction

Like many rural communities around the United States, Maryland's Eastern Shore needs to develop new wealth creation strategies which draw upon, and strengthen, the region's natural, human and intellectual capital base. Soil fertility, water quality, and human ingenuity are assets which have developed this 3,324 square mile region. Finding sustainable market-based solutions, which conserve and strengthen these assets by making healthy soil and clean water inputs to a new local food supply chain, presents the region with a commercial opportunity that needs to be further explored. Understanding the economic, ecological, and human dimensions of this opportunity in a quantitative way, developing the business case for increasing crop diversity, and modeling the potential impacts on the region's natural and human resources are the principal goals of this study.

Local food system development offers Maryland's Eastern Shore community an opportunity to supply commodities that are increasingly demanded in local, regional, and national markets. Such an activity will not only keep more dollars circulating in the regional economy and strengthen trade flows between rural and urban communities to the north and west, but improve access to fresh healthy food, helping to close a dietary gap and improve public health in the region. If regenerative farming techniques are used, growing local food could lower the cost of growing while building soil capacity, and simultaneously produce a highly-differentiated, nutritious good.

Yet as many rural communities in the U.S. leverage their agricultural capacity, Eastern Shore's local food movement has languished. The chief reason, in our opinion, is because the message that food production can strengthen this diverse, nine-county region has not been heard beyond the "usual" community of activist stakeholders: advocates of organic food, hunger relief organizations, and the like. A strong business case, resonating with the vast majority of residents who do not consider themselves locavores or organic consumers, was not made. Missing from the dialog have been metrics of local food production's regional impact, which we produce in this study. By taking the expenditure pattern of a local USDA certified organic farm-retail operation, we have estimated the regional impact on economics, dietary needs and

environmental burdens. Our objective is to reintroduce local food systems, based on “triple bottom-line” implications, as a tool for expanding regional well-being.

The Eastern Shore currently has over one million acres in farms in addition to fallow land. Augmenting return on farm equity and regional income by accessing regional, higher-value markets presents an opportunity for the region to improve its fiscal, social and environmental position in the 21st century.

Using a More Comprehensive Measure of Wealth

There is a connection between wealth, achieving sustainable rural economic development, and well-being. A more comprehensive definition of regional wealth, which is place-based, is beginning to be recognized. Just as financial gain in one local industry at the expense of another can diminish growth in the area or result in a zero-sum gain, a financial capital gain at the expense of the environment (natural capital) or public health (human capital) offsets or diminishes local wealth too. Conventionally, regional wealth has been perceived as a market-based, physical asset; however, broader measures are being acknowledged (Pender, Weber, Johnson and Fannin, 2014).¹ For many years non-marketed assets like clean air, water and good public health were not explicitly valued and the cost of degrading them has been low. Yet today, given the rising expense of healthcare, few would argue that these regional social attributes are not assets. Measuring wealth across eight categories of capital: financial, natural, human, intellectual, social, political, cultural and physical, builds the basis for a more comprehensive social account. This broader definition has profound effects on how communities like the Eastern Shore measure its wealth and regional value supporting a triple bottom-line (TBL) economic, social and environmental approach to impact assessment.

Natural capital has an explicit definition, which resonates with rural communities. Pender *et al.* (2014, p. 18) define it as, “the stock of healthy environmental assets (*e.g.*, air, water, land, flora, fauna, etc.) in a region, which are capable of producing returns in the form of goods and services, including non-marketed ecosystem

services.” It includes both renewable resources, such as nutrients and water that cycle in nature, and non-renewable resources, like metal ores and petroleum, which are depleted by extraction. Natural capital is unique because it cannot be created; conversely, it can be degraded or destroyed. Restoration of some natural capital, such as ecosystem services, can be restored; for others, depletion is permanent.

This paper takes a deeper look at assessing the local impact of food production and marketing beyond direct-to-consumer activities (*e.g.*, farmers’ markets and community supported agriculture) to model scales associated with intermediated markets, such as hospitals and school districts, either directly or through their food service management contractors. Maryland’s Eastern Shore, along with its Delaware and Virginia neighbors, could potentially serve growing Mid-Atlantic markets supported by new distribution infrastructure that exploits surface as well as marine highway transportation.

Market, Social and Environmental Drivers

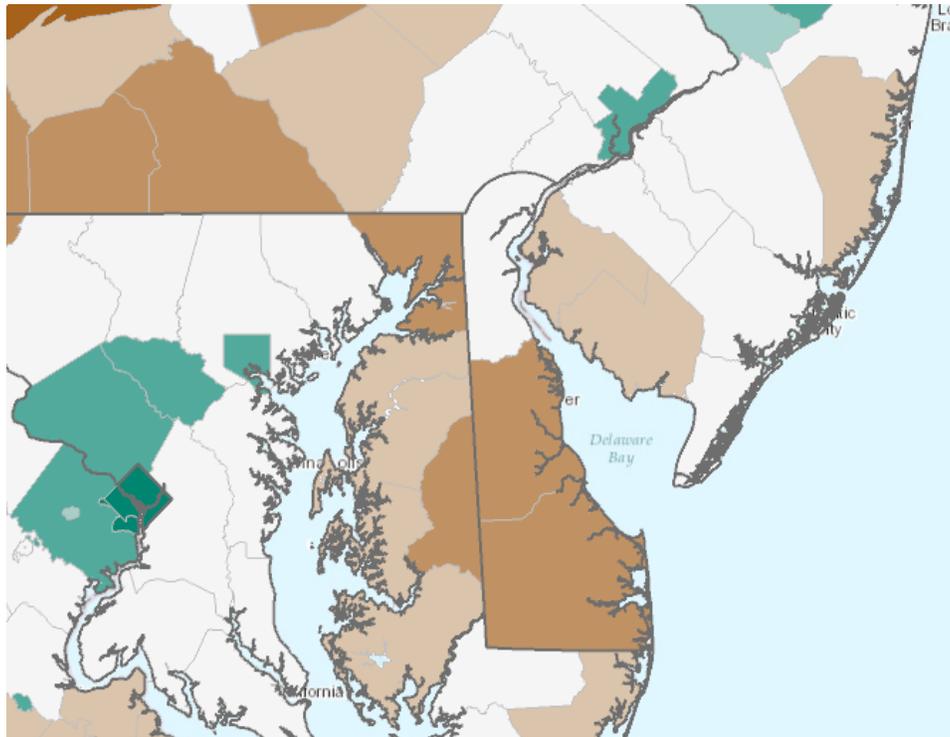


Figure 1: This map shows the market potential, from survey data, for an adult to eat organic food regularly in 2015, by state, county, ZIP Code, tract and block group. The darkest green areas indicate the highest potential and the dark brown, the lowest. Grey indicates average potential. Source: ERSI and GfK (April 2015)

Market Drivers

Within 50 miles of the Eastern Shore is an expanding market for fresh organically grown food. Residents from nine western shore counties: Anne Arundel, Baltimore County, Baltimore City, Calvert, Charles, Howard, Montgomery, Prince Georges, and St. Mary's spend \$6.5 million on local fruits and vegetables annually. Although no direct data exist describing spending on organic fruits and vegetables, the map above (Fig. 1), indicates that between Philadelphia-Wilmington and Baltimore-Washington, D.C. Metropolitan Statistical Area (MSA) corridors, there are 567,541 adults that report a greater than 20 percent chance, above the national average, for eating organic food regularly. We have made the

assumption that consumer preferences for organic food would equate to purchasing local food grown via regenerative agriculture, a practice which aggressively builds soil health and its productivity beyond certified organic techniques.

U.S. sales of organic food in 2014 reached \$39.1 billion. The organic sector should maintain double digit growth, according to the Organic Trade Association (<http://ota.com/resources/market-analysis>), and surpass \$43 billion for 2015. Organic sales are now near a milestone of five percent of the total food market, while acreage devoted to organic agriculture is less than one percent of total U.S. cropland.² Organic food production has failed to keep pace with demand, generating growth limiting supply shortages. The Eastern Shore has over one million acres in agriculture production, has water access, and is within 150 miles of some of the largest markets in the nation. A developed regional food system, with regenerative or organic agriculture at its core, could have a profound effect on household income, farm equity returns, and county and state tax revenue.

Social Drivers: Public Health

Maryland's Eastern Shore reflects the nation when it comes to diabetes and obesity. The state's diabetes incidence rate of 9.2 percent is on par with the U.S. average of 9.3 percent for adults. Six Eastern Shore counties -- Dorchester, Somerset, Worcester, Wicomico, Caroline and Cecil -- as of 2012 had rates above the state average. According to the Center of Disease Control and Prevention (<http://www.cdc.gov/diabetes/atlas/obesityrisk/24/atlas.html>), Dorchester and Somerset topped the list with 12% and 11.9%, respectively. Current data ranks Maryland at 21 of 51 states (including the District of Columbia) with a 10-17 year old obesity rate of 15.3 % according to

<http://stateofobesity.org/states/md/>) and age-adjusted obesity rates in Eastern Shore counties vary from 26.7% to 39.6% in 2012. The state average, as of 2014, was 29.6%.

In many of those counties, public school districts could pro-actively team with Maryland's Department of Health and Mental Hygiene to fine-tune healthy food choices based on community/county health measures. This would significantly increase local food access into the procurement programs, possibly having a positive health impact on persons from food insecure households. According to IMPLAN, Eastern Shore school districts spend approximately \$3,887,000 in food management services annually. Given the 2015 Dietary Guidelines for Americans (DGA) recommendations, expanding local fresh food access to state and local (non-education) government agencies could present a significant market opportunity for Eastern Shore growers.³

Planning meals around public health goals is a practice embedded in the national Farm to School initiative, but data on how much fresh, local food is supplying Eastern Shore school districts are in question. In the 2013-14 academic year a \$789 million investment in local food was made in the Farm to School program and nationally 42,587 schools participated. Maryland ranks fifth in the nation for the amount of local food served in schools, spending over \$18 million and an average of 23 percent of the districts' food budgets.

Yet among the nine Eastern Shore school districts, as of 4/6/16, Dorchester County reported a total school food budget of only \$10,000; Talbot County said it spends 2.6 percent on local food and when asked: "Looking forward do you anticipate your local purchases will increase, decrease or stay the same?" their response was the latter. Kent County had no data in their economic impact category; Cecil, Caroline, Queen Anne's and Worcester Counties reported spending 5.7, 19, 7.6 and 1.1 percent,

respectively. Somerset reported spending 9.6 percent of a total food budget of \$780. Data from Wicomico are not available. More research and a better understanding of county-level, school district food procurement may yield opportunities for local food producers and hubs to better understand the requirements of institutional buyers and the expectations of community growers and residents. Should Americans consume the levels of fruits and vegetables recommended, it is widely acknowledged the current U.S. food system will not currently be able to meet that demand. Local sources, given a sustainable supply of labor and transportation infrastructure, may play a significant role in closing the gap.

Environmental Drivers

Data show that the largest single contributor to aquatic pollution in the Chesapeake Bay watershed is the agricultural industry, and attempts to control nitrate (NO₃) and phosphate (PO₄) pollution are well-studied problems. The federal Clean Water Act established scientifically based Total Maximum Daily Loads of pollutants (TMDLs) for 92 subdivisions of the Chesapeake Bay Watershed. Each TMDL defines the pollution limit for a section of the watershed, with the goal of restoring “fishable, swimmable” waterways in the Chesapeake Bay. TMDL mandates a limit on the amount of nitrogen, phosphorus, and sediment that can legally be emitted into a section of the Bay. Yet to meet those TMDL limits, states must develop goals, and monitor progress, in the form of Watershed Implementation Plans (WIPs). One estimate for Talbot County ranged upwards to \$1,200,000,000 *just for the urban components of the WIP*. This is the hidden cost of “conventional” production agriculture – monoculture grain farming, and large-scale poultry farming -- for one county on the Eastern Shore.

As a buffer to the impacts of conventional farming, expanding regenerative agriculture in food production strengthens the demand for healthy soil and clean water, which also conserves the region's natural capital. Regenerative agriculture's techniques extend beyond those demanded by sustainable agriculture or certified organic practices. It literally *regenerates* soil health and productivity, which in the long run lowers the costs, reciprocally boosting the returns, to farming. Also, a market-driven expansion of regenerative farming could establish sustainable buffers, offsetting those conventional agricultural practices that impair or degrade the inputs to farming and regional natural capital. Given conventional "factory" farming's impact on the environment and its potential to reduce a regenerative farmer's output, that material damage would have a market value where relief could be sought. This is a market driven approach that would naturally limit activities that pollute, and reduce dependence on publicly funded regulation. For example, the performance of Maryland's Phosphorous Management Tool (PMT) rests on publicly-funded monitoring of "hotspots" and makes poultry growers accountable for the proper disposal of excess litter. Proprietors of farming activities requiring clean water and ecologically balanced soil profiles limit the production of pollution, which presents a business risk. Growers, acting in their own best interests, could implement a legal tool or mechanism that limits these types of pollution.

A Changing Eastern Shore: Problem 1

Lifestyle draws and retains many to call this unique place home, but it comes at an increasingly higher cost. Between the 2008-10 and 2011-3 periods, average median household income for Maryland fell slightly as for most of the nation. Yet for the Eastern Shore the decline was over twice as large. According to the Maryland Department of Planning, for the 15 Maryland counties west of the Chesapeake Bay, total median household income fell to -3.64 percent; Garrett County led, declining to -12.9 percent (Fig. 2). In contrast, the Eastern Shore's median household income declined to -8.47 percent. Somerset, Caroline, Talbot and Dorchester fell: -25.7, -16.5, -12.6 and -9 percent, respectively.

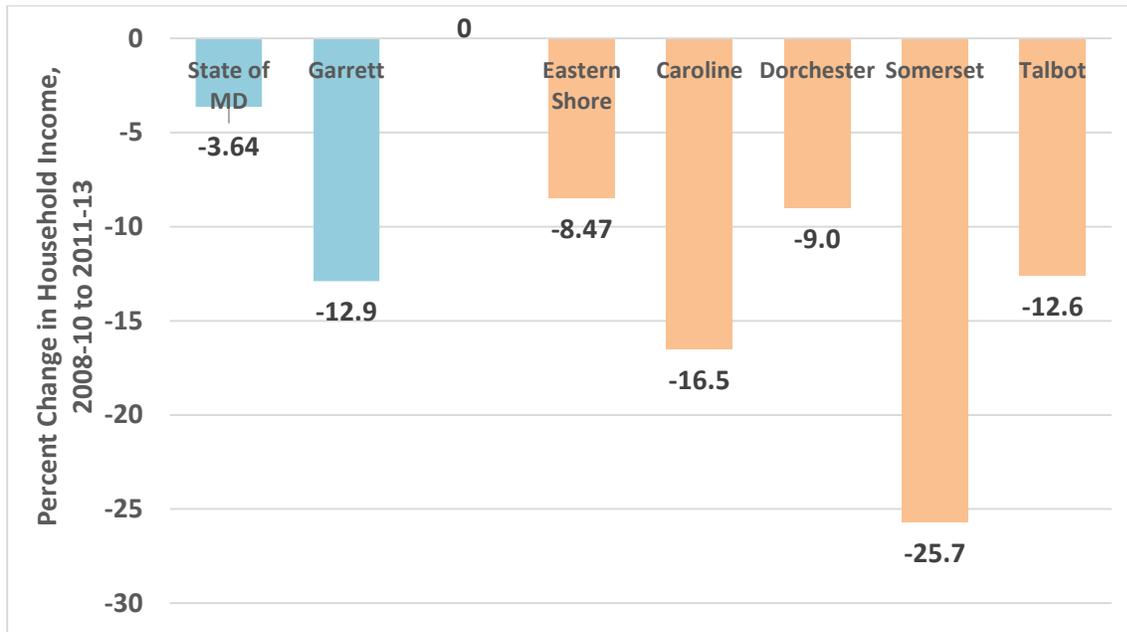


Figure 2: The Eastern Shore lost more household income than the rest of Maryland between the periods 2008-10 and 2011-13. Caroline and Somerset, large agricultural counties, led in losses.

These counties also lost population from 2010 to 2014, as Maryland's overall number of residents increased. While four counties gained, five lost residents for an overall net .8 percent gain. Wicomico, Queen Anne's, Cecil and Worcester Counties gained; Somerset, Kent, Caroline, Talbot, and Dorchester Counties lost residents. Five of the nine counties had the weakest unemployment rate change figures from 2014-15 of any other county outside of Baltimore City. Overall, the rate of unemployment on the Eastern Shore stands 24 percent higher than for the rest of Maryland. "If you do finally find a job, odds are it's going to be across the bridge or in Middletown" [DE], said one Sudlersville resident. As a region, the Eastern Shore lags the state and its most rural districts are feeling the most pain.

The Steady Shift in Farm Output: Problem 2

"Dairy farming is the most important farm enterprise[s] in the county. It is decreasing in importance, but still accounted for about 49 percent of the value of all farm products sold in the county in 1964. Grain, as a cash crop, is the second most important farming enterprise. It is increasing in importance and accounted for about 24 percent of the value of all farm products sold in 1964. Livestock and livestock products, ex. poultry and dairy products, accounted for about 12 percent of the value of all farm products sold in 1964; poultry products accounted for about eight percent of the total value."

--Cecil County's Soil Survey of 1973.⁴

Today, corn for grain takes the lead (21.6% of farm product value), followed by poultry (14.6%), dairy (10.5%) and beef (4.9%), reflecting, in part, a change in consumer preferences. In 1973, Americans consumed 39.8 pounds of chicken. By 1993 and 2013, annual total chicken consumption increased to 69 and then 83.3 lbs per year, respectively. Delmarva Poultry Industry (DPI) estimates that in 2016, U.S. per capita consumption will reach 91 lbs. Maryland produced 287,800,000 (meat) chickens in 2014 generating a production value of slightly less than \$1 billion. According to DPI, the Eastern Shore's

Somerset, Caroline, Wicomico, Worcester and Dorchester Counties ranked 18th, 20th, 28th, 29th and 82nd in America as leaders in broiler chicken production. The 2012 U.S. Census of Agriculture ranked Sussex County, Delaware first among America's counties in meat chicken production and Kent County ranked 57th. Poultry is here to stay, and is poised to expand; however, if current trends are indicators of the future, it will not be an engine for regional growth that improves the well-being for most Eastern Shore residents.

Since 1982, the Eastern Shore region lost 21 percent of its farmland. There was an 88 percent loss in tomatoes, a 45 percent loss in sweet corn, a 21 percent loss in potatoes, and a 92 percent loss in kale production. Dairy cows, layer hens, apple and peach production fell: 60, 38, 70 and 73 percent, respectively. Overall there was even a reduction in the acres of corn for grain too, but since 1992 much of it was offset by increases in yield as GMO varieties became widely used.

Commercial broiler chicken production grew as the number of birds increased along with their weight. Poultry supports approximately 7,625 jobs across five sectors representing 3.25 percent of the total Eastern Shore workforce, with much of the meat chicken production and processing located in the lower and central counties while grain production is found practically everywhere. The efficiency of the poultry supply chain enables it to expand production with only marginal increasing in operating costs. For the Eastern Shore, meaningful job creation in the agricultural sector, including value-added processing activities and sustainable environmental benefits, will come from regenerative agricultural practices that supply local and regional markets.

The Risks of Global Markets: Problem 3

Seventeen percent of U.S. poultry production is predicted to be exported in 2016, according to the USDA Foreign Agriculture Service (<http://apps.fas.usda.gov/>). This figure has fluctuated between 19.7 and 16.5 percent since 2011, and it may increase quickly should the strength of the U.S. dollar wane and the current Trans-Pacific Partnership trade agreement before Congress be ratified. Yet, with a new level of global market exposure come new risks. One will be currency volatility. When the U.S. dollar is strong, vis-à-vis other currencies, American goods are more expensive to purchase. Economically growing South Asian countries may currently be willing to pay for certain American goods like poultry now, yet should their currency's value fall enough against a strengthening U.S. dollar, they may choose cheaper substitutes like Brazilian chicken. Another risk is that countries may engage in currency manipulation in effect limiting our export sales. Should this occur, such an intentional devaluation would hurt revenues and U.S. jobs by neutralizing the benefits of the tariff reductions (Economic Policy Institute, 2014).^{5/6}

The General Local Need

Meeting the income needs of the region requires it to leverage its strengths. At present, this region's exposure to the poultry sector exposes it to industry risk without a plan to strategically diversify. Environmentally, activities are needed that support, rather than compromise, soil health and water quality explicitly. Monitoring damages or unfunded mandates have limited, if not diminishing, impact in the long run, and will always be driven by politics. Focusing on activities that generate higher returns on farm equity, and that see environmental quality as an input to producing market-demanded local food, presents opportunity for Eastern Shore household income, public health and the environment. This triple bottom-line approach is one sustainable plan to boost regional wealth.

What has been missing from the local food systems discussion, and is needed now, are assessments which define the impacts of food production activities. Employment, labor income (including employee compensation and proprietor income), value added and output from this new sector can be defined. Input-output analysis is the best tool for modeling industry change in this sector given modifications. Input-output analysis has been in the private-sector and economic-development domains commercially since 1993. There is no other platform that is as robust and well-respected as the IMpact for PLANning (IMPLAN) system. In IMPLAN a regional model contains demographic and economic data; all of its sectors (in the case of the Eastern Shore, 318 sectors) are accounted for and linked. The user has the ability to build a unique sector, which will have its own inter-industry linkages based on its spending pattern. Thus, the resulting regional economic impacts, reflective of successive rounds of trades/transactions, can be modeled. The strength of the IMPLAN system is its transparency and flexibility. IMPLAN's limitations is that it is a static model, not recommended for projecting out more than five years, being linear it cannot model increasing returns to scale. It does not have an organic foods sector yet in its sectoring scheme; however, modifications can be made to replicate that sector in much the same way a food hub sector was built for this project.

A Brief Description of Input-Output Analysis

The value of the Input-Output (I-O) analysis examines the movements of products and services between industries, households and governments to create a detailed mathematical description of an economy. Once the economy is modeled, the resulting accounts are available for economic manipulation.

“Essentially it is a method of analysis that takes advantage of the relatively stable flow of goods and services among the elements of our economy.”

-- Dr. Wassily Leontief, developer of modern Input-Output techniques

The IMPLAN system is a general input-output model that is comprised of software and regional data sets. IMPLAN data sets, constructed annually, come from three primary sources:

1. the U.S. Bureau of Labor Statistics (BLS) Covered Employment and Wages (CEW) program and the BLS Consumer Expenditure Survey;
2. the Bureau of Economic Analysis (BEA) Regional Economic Information System (REIS) program and the Benchmark I/O Accounts of the U.S., the BEA Output estimates;
3. the Census Bureau County Business Patterns (CBP) program, Decennial Census and Population Surveys , Economic Censuses and Surveys, and the Department of Agriculture Census.

Comparative Analysis of Two Scenarios

The initial objective of the project was to build a “food hub” sector into the Eastern Shore region, and run industry change scenarios, reflecting changes in final demand, to assess regional impacts. Initially the 14-county Delmarva region was selected as the study area, but to sharpen the analytical focus, this

was reduced to the nine-county region of Maryland's Eastern Shore. Next, framing food hubs and the activity of food production as potentially valuable economic activities meant using a locally viable operation as a model.

Framing the Analysis

We define a food hub as a business or organization that actively manages the aggregation, distribution, and marketing of source-identified food products, primarily from local and regional producers, to strengthen their ability to satisfy wholesale, retail, and institutional demand. Measuring the regional impact of a food hub requires knowing its expenditure pattern and applying it, given a user defined level of sales, to the modeled region. On the Eastern Shore there are no formal food hubs. However, a USDA certified organic grower who also operates a Community Supported Agriculture (CSA) program and retails locally-sourced natural and organic foods from beef products to artisan, value-added products agreed to provide the information. In addition to growing some of their food sold, they have three hoop houses, a walk-in cooler, and a box truck, and they conduct aggregation, washing, packing and distribution functions. Open year-round, this establishment has been in operation for ten years; many of their normal operations reflect the functions of a for-profit food hub. Table 1 expresses the input requirements of our proxy food hub for every dollar of sales (note that fractional values sum to 1.00). Using an IMPLAN technique, Analysis-by-Parts (ABP), a food hub's spending pattern was replicated.

Table 1

Analysis-by-Parts Components

		Seed -	0.0227
		Supplies -	0.0192
		Fertilizer -	0.1213
		Soil Mix -	0.0054
		Propane -	0.0117
		Land Rent -	0.0059
		Fuel -	0.0016
		Organic Cert. -	0.0031
		Electricity -	0.0039
		Fees - farmers' market	0.0078
		Health Dept. license -	0.0020
		Auto Expense -	0.0141
Employee Comp.	0.4042	Intermediate goods	0.2187
Proprietor Income	0.3771		
<u>Labor Income</u>	<u>0.7813</u>		

In IMPLAN, Single Regional Input-Output (SRIO) analysis measures the relationships between suppliers, producers and final demanders within one region. If the study area is Talbot County, for example, all the trade activity within that county is measured. In reality, economic activity in Talbot County may spill over to adjacent counties like Caroline, Dorchester or Queen Anne's due to trade flows (indirect effects) or where employees spend a portion of their labor income (induced effects). When modeling a region, care should be taken not to select too disaggregated a study area, because impacts are more accurate in functional economies.⁷

To capture all these effects across regions and ensure that we modeled a functional economy, we created a single nine-county region called the Eastern Shore. With approximately 317 industries, 177,654 households, total employment of 234,662 and a Gross Regional Product (GRP) in excess of \$18 billion, trade and people on the Eastern Shore represented a functional economic market area for our analysis of two different activities.

The Analysis with Two Scenarios

The American Farm Bureau Federation indicates that a fully ratified Trans-Pacific Partnership trade agreement would mean an additional \$13,558,700 in sales to Maryland poultry. Given that the single most important agricultural industry to the region is currently poultry, we designed a simple comparison between the regional impact of a \$13,558,700 increase to the poultry industry, which included poultry & egg production (Sector 13) and poultry processing (Sector 92), and the regional impact of a \$13,558,700 food hub. IMPLAN's 536-sector scheme was used. We then compared the regional impacts of these two single activity scenarios.

A \$13,588,700 shock is plausible for the local food scenario given the documented regional demand. To put that industry change figure in perspective for the food hub, if each of the approximately 5 million households between Philadelphia and Washington D.C. purchased \$2.80 worth of Eastern Shore-grown food a year, assuming it all flowed through our food hub, annual sales would be \$14 million. According to IMPLAN's database, Maryland households have an industry demand for fruits and vegetables in excess of \$27,450,000. If Eastern Shore food were regeneratively grown, then the 567,541 adults with a greater than 20 percent chance of eating organic food regularly represents an expenditure of only \$23.94 per adult, per year. The assumption being made is that all inputs can be sourced regionally.

IMPLAN results use the following terms regularly:

Employment: Total annual average jobs. This includes self-employed, wage, and salary employees and all full-time and seasonal jobs based on a count of full-time/part-time averages over 12 months.

Labor income (LI): Defines the total value paid to local workers within a region. Labor income is the income source for induced household spending. Labor Income is defined as the sum of Employee Compensation and Proprietor Income.

Value Added (VA): Comprised of Labor Income, Indirect Business Taxes and Other Property Type Income. It is the “value added” to the intermediate goods to make the final good. It describes the additional economic activity above and beyond the industry’s inputs required for successful production.

Output: Total gross sales. $Output = Intermediate\ Expenditures + Value\ Added$. The term is also used to describe total production or sales for the year for a region in a given industry.

Tax Impacts: This report shows state, local, and Federal taxes generated from a model scenario. IMPLAN combines the state and local tax impact because they presently do not have the underlying data necessary to break out state from county and city taxes in a region.

IMPLAN models generate an Impact Summary, which contains the following metrics in dollars:

Direct Effects: measures the initial event as defined by the user, in this case a change (an increase) in annual sales.

Indirect Effects: measures the iterations or rounds of business-to-business purchases made in response to the initial impact spent within the study area on supplies, services, labor and taxes.

Induced Effects: measures the impact of the wages (see “Labor Income,” above), derived from increased direct and indirect activity, as that money is spent and re-spent in the study area.

Regional multipliers are easily calculated once the data is generated.

Multipliers: These express the total impact associated with a marginal increase in a single direct impact – an outcome generated by the modeled change in economic activity. For example, an Employment Multiplier is calculated by dividing Total Employment (TE) by Direct Employment (DE), i.e. TE/DE . An employment multiplier of 1.5000 means that for every two direct hires, one is generated in the study area; if it is 1.3333, for every three direct jobs, one is generated in the study area.

A Sector Comparison

We modeled our Eastern Shore food hub with annual sales of \$13,588,700 and compared it to a poultry processing industry change of the same magnitude (simulating TPP ratification). In many respects, the food hub model outperforms the Poultry/TPP model, particularly in metrics that strengthen regional income: direct jobs to industries are listed in Tables 2 and 3, including state and local tax revenue.

The modeled food hub creates 65 direct jobs based the current operator’s estimates for this level of output. This would reflect an average output per worker value of \$208,600, generating an additional nine jobs indirectly due to inter-industry transactions among suppliers, and 52 more induced jobs due to wages at all levels being spent on goods and services, generating 127 total jobs on the Eastern Shore (Fig. 3) given this stimulus. The employment multiplier of 1.9480 is calculated by dividing the total by the

direct effect (in this case, 126.6/65). The employment multiplier implies that *for every 10 jobs the food hub creates, an additional nine will be created in the region.*

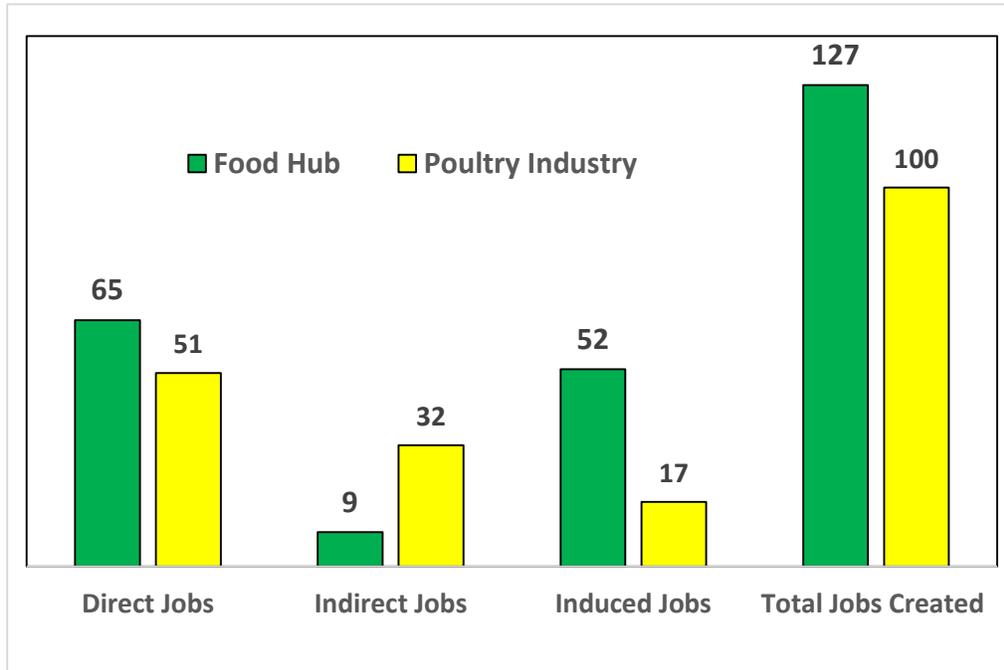


Figure 3: A \$13,558,700 shock modeled in IMPLAN to the poultry industry and to a food hub. The food hub, as modeled, created more direct, induced, and total jobs.

Direct labor income of \$10,593,412 generated a total labor effect of \$12,960,441 producing a regional multiplier of 1.2234. Direct total value added of \$10,711,373 generated a total effect value added of \$15,396,726 generating a regional value added multiplier of 1.4374, for one dollar of value added generated by the food hub an additional 44 cents is created in the region. Given the food hub's production function, the initial shock of \$13.6 million generates a total effect of \$21.6 million, generating a regional output multiplier of 1.596 implying that *every dollar of food hub sales generates an additional 60 cents of regional output.*

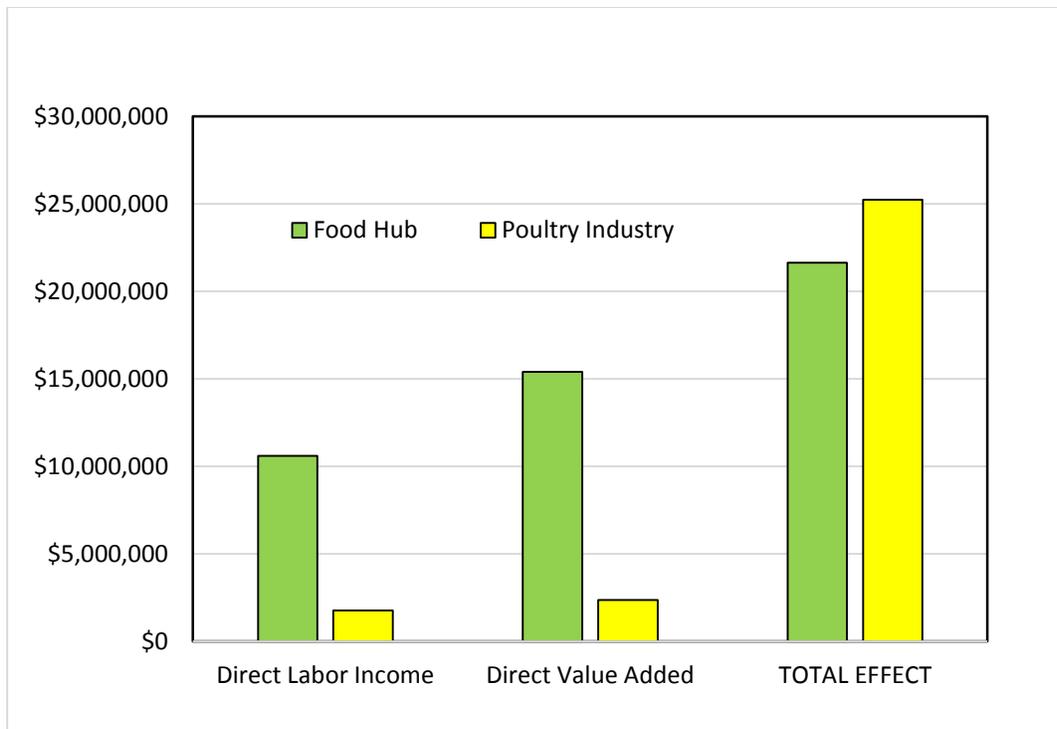


Figure 4: Relative impacts of a \$13,577,800 shock to the modeled food hub sector, and to the poultry and egg sector. A stimulus of this size to the poultry has greater overall effect, but by a small margin; direct labor income and direct value added to the regional economy are greater for the food hub model.

The top industries affected include “support activities for agriculture and forestry” (IMPLAN sector 19), which contains over 100 possible aggregated North American Industry Classification System (NAICS) code descriptions ranging from crop-dusting to waxing fruit and vegetables. Field research would have to be conducted to identify which activities are affected in the region. Other industries included: full and limited-service restaurants; real estate; wholesale trade (another highly aggregated IMPLAN sector [395] with hundreds of different NAICS descriptions); local medical facilities (hospitals, physicians’ offices, and nursing and community care facilities); retail food and beverage stores; general merchandise stores; and truck transportation. *This food hub expenditure pattern, given sales of \$13,588,700, generates \$562,272 in state and local tax revenue.*

By contrast, the anticipated cash receipts of \$13,588,700, as described by the American Farm Bureau Federation, which the poultry industry should see as a result of TPP ratification would create 51 direct jobs, an additional 32 indirectly due to inter-industry transactions among suppliers and 17 more induced due to wages at all levels being spent on goods and services, *generating a total 100 jobs on the Eastern Shore*. The employment multiplier of 1.9577 is, again, calculated by dividing the total by the direct effect (in this case 100/51.3). The employment multiplier implies that for every 10 jobs the poultry & egg production and poultry processing sectors creates, an additional ten jobs will be created in the region. Direct labor income of \$1,765,628 generated a total effect of \$4,341,044 producing a regional multiplier of 2.4586. Direct total value added of \$2,355,594 generated a total effect value added of \$7,148,541 generating a regional value added multiplier of 3.0347, *for every one dollar of value added generated by the poultry industry an additional \$2 is created in the region*. Given the poultry industry's production function, the initial shock of \$13.6 million generates a total effect of \$25.2 million, generating a regional output multiplier of 1.8608 implying that *for every dollar poultry processing and poultry & egg sales generates, an additional 86 cents of regional output is produced*.

The top industries affected include "Wholesale trade" (IMPLAN sector 395), a highly aggregated sector containing over 100 possible aggregated North American Industry Classification System (NAICS) code descriptions. Other industries included: truck transportation, full and limited-service restaurants; management of companies and enterprises; real estate; support activities for agriculture and forestry, hospitals and accounting, tax preparation, bookkeeping and payroll services. *This poultry industry expenditure pattern, given sales of \$13,588,700, generates \$482,740 in state and local tax revenue.*

While the multipliers for the food hub scenario were weaker than for the poultry industry the direct labor income was higher as was the tax revenue; increasing regional household income and tax revenue are target metrics. Note that proprietors, self-employed individuals, do not make payments to State and Local government, so the entry in Tables 2 and 3 have a value of zero. Sales of \$13,588,700 to the poultry industry generated 16 percent less than the food hub scenario. Given the social investment implications of developing new sources of tax revenue, especially for many fiscally stressed school districts, this is encouraging and warrants deeper analysis.

Table 2

Scenario 1: Food Hub Impact Summary

Impact Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	65	\$10,593,412	\$10,711,373	\$13,558,700
Indirect Effect	9	\$340,669	\$647,546	\$1,357,365
Induced Effect	52	\$2,026,360	\$4,037,807	\$6,717,572
Total Effect	127	\$12,960,441	\$15,396,726	\$21,633,637
Multipliers	1.9480	1.2234	1.4374	1.5956

Top Industries Affected in terms of Employment

Description	Direct	Indirect	Induced	Total
*Food Hub Activity	65.00	0.00	0.00	65.00
Support activities for agriculture and forestry	0.00	3.70	0.00	3.70
Full-service restaurants	0.00	0.00	3.50	3.50
Real estate	0.00	0.50	2.70	3.20
Limited-service restaurants	0.00	0.00	3.00	3.10
Hospitals	0.00	0.00	2.90	2.90
Wholesale trade	0.00	1.20	1.50	2.70
Offices of physicians	0.00	0.00	1.90	1.90
Retail - Food and beverage stores	0.00	0.00	1.90	1.90
Retail - General merchandise stores	0.00	0.00	1.80	1.80
Nursing and community care facilities	0.00	0.00	1.70	1.70
Truck transportation	0.00	1.10	0.40	1.40

State and Local Tax Impact

Employee Compensation	Proprietor Income	Tax on Production and Imports (TOPI)	Households	Corporations	Total
\$3,526.00		\$439,937.00	\$86,366.00	\$17,416.00	\$547,215.00

Table 3

Scenario 2: Poultry (with TPP) Impact Summary

Impact Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	51.3	\$1,765,628	\$2,355,594	\$13,558,700
Indirect Effect	32.0	\$1,911,310	\$3,468,090	\$9,467,052
Induced Effect	17.2	\$664,107	\$1,324,856	\$2,204,028
Total Effect	100	\$4,341,044	\$7,148,541	\$25,229,780
Multipliers	1.9577	2.4586	3.0347	1.8608

Top Industries Affected in terms of Employment

Description	Direct	Indirect	Induced	Total
Poultry processing	51.31	2.59	0.02	53.92
Poultry and egg production	0.00	11.28	0.01	11.29
Wholesale trade	0.00	2.61	0.50	3.10
Truck transportation	0.00	2.89	0.13	3.02
Full-service restaurants	0.00	0.37	1.15	1.51
Management of companies and enterprises	0.00	1.27	0.09	1.37
Limited-service restaurants	0.00	0.36	0.99	1.36
Real estate	0.00	0.43	0.89	1.32
Support activities for agriculture and forestry	0.00	1.14	0.01	1.14
Hospitals	0.00	0.00	0.95	0.95
Accounting, tax preparation, bookkeeping & payroll serv.	0.00	0.59	0.18	0.77

State and Local Tax Impact

Employee Compensation	Proprietor Income	Tax on Production and Imports (TOPI)	Households	Corporations	Total
\$5,850.00		\$293,493.00	\$159,662.00	\$23,735.00	\$482,740.00

The 65 total annual average jobs that the food hub supports, at \$13.557 million in annual sales, pays an average employee compensation of \$83,792.77 annually, is more than twice what poultry workers can expect to earn according to the Bureau of Labor Statistics (<http://www.bls.gov/oes/current/oes513023.htm>). National employment estimates indicate the median annual wage is \$25,650; should average wages rise in the region to \$15 an hour, it would produce wages paying \$30,610. All this reflects, cumulatively, the difference in the level in labor income associated with the food hub's production function drives the larger induced effects in the region. If we think of the induced effects as the tide that regionally lifts all boats, then the food hub activity produces a much higher tide.

The Environmental Impacts

We extended this comparison to include environmental impacts for both comparative scenarios. Using the Carnegie-Mellon University Economic Input-Output Life Cycle Analysis tool (EIO-LCA), which is based on IOA, we modeled the environmental outcomes of a \$13,558,700 increase in the poultry industry, and vegetable and melon farming activities, a close approximation for most agricultural activities related to the food hub. We examined greenhouse gas outputs, land and groundwater use, and the drivers causing nutrient pollution (eutrophication) in local waterways and the Chesapeake Bay. Unlike IMPLAN, EIO-LCA is not regionalized; its results should be interpreted in a global context.

Agriculture creates a set of environmental impacts which collectively impact the natural capital of the Eastern Shore. Those impacts can be direct, such as groundwater withdrawals and poultry litter disposal, or indirect, such as the greenhouse-gas consequences of electricity generation. We took a

holistic Life-Cycle Analysis approach (LCA), one which looks at the environmental factors affected throughout the life-cycle of a product and includes the goods and services in the supply chain needed to produce them. LCA attempts to account for raw materials used, waste products produced, and the impact of packaging and transportation, among other factors. Such analysis looks not only at the industries stimulated by economic changes, but also the “upstream” and “downstream” environmental consequences of economic activity.

To assess the LCA impacts of Eastern Shore poultry agriculture, we turned to an online analytical tool, Economic Input-Output Life-Cycle Assessment (EIO/LCA), developed and hosted by Carnegie Mellon University’s Green Design Institute (<http://www.eiolca.net>). The EIO/LCA model allows the user a range of national and international baseline economic data, and returns a wide variety of environmental variables. For US economic data, the model returns results on a per-industry basis, using NAICS industry codes. Thus, EIO/LCA allows a user to examine the economic impacts of specific industry sectors, and their ecological outputs, based on a level of overall economic productivity or output. This platform does not enable the user to customize or construct sectors like IMPLAN; however, EIO/LCA results can be interpreted in tandem with IMPLAN because both use the NAICS codes.

For example, a user could examine the impact of \$1,000,000 of production in the “Light Truck and Utility Vehicle Manufacturing” sector (NAICS code 336112). EIO/LCA returns an estimate of 603 metric tons of greenhouse gases produced as a consequence of that activity. (Greenhouse gases are expressed as CO₂ equivalent, or CO₂e.) The model further estimates that the two leading sources of that CO₂e are from the “Power generation and supply” sector (NAICS 221100) and the “Iron and steel mills” sector (NAICS 331110). Further estimates are available for other greenhouse gases, groundwater withdrawals, air and

water pollutants, toxic discharges, transportation emissions, and some known carcinogens released as a function of that economic activity.

We selected the 2002 Benchmark US Producer Price data available in the EIO/LCA model, which is the most recent data the model includes, and analyzed the environmental impact of an increase in the Chicken Egg Production sector (NAICS 112310), Broilers and Other Meat Type Chicken Production (112320), and Turkey Production (112330). These three sectors are bundled together by EIO/LCA and represent the regional poultry industry well. For comparison purposes, we modeled a similar increase in the Vegetable and Melon sector in EIO/LCA, which combines NAICS codes for Vegetable and Melon Farming (NAICS 11121), Potato Farming (111211), and Other Vegetable (except Potato) and Melon Farming (111219). These data are loosely representative of the Delmarva vegetable-farming industry; potatoes are not a primary crop in the region, but vegetables and melons, notably cantaloupes, are grown on the peninsula.

We modeled changes to both industries based on projected cash receipts from the Trans-Pacific Partnership (TPP) trade agreement, currently under consideration by the federal government. The American Farm Bureau Federation anticipates that the Trans-Pacific Partnership agreement, if approved, would bring an additional \$13,558,700 in sales to Maryland poultry. As a comparison, we modeled the ecological impacts of that \$13,558,700 to both the poultry industry and to the “Vegetable and Melon” sector, our food production proxy, using the EIO/LCA tool.

What was found is the conventional poultry industry’s estimated environmental footprint is, in many ways, greater than vegetable and melon farming.

Greenhouse Gas Emissions

Greenhouse gas emissions, which cause warming of the planet's atmosphere, are one environmental consideration for agriculture. Monoculture grain agriculture, a significant component of the supply chain for poultry which drives a \$3 billion agricultural industry on the Eastern Shore and much of the Delmarva Peninsula, is a contributor of greenhouse gases.

For a \$13,558,700 production increase in poultry and egg production, EIO/LCA estimates an additional 32,000 metric tons (mt) of carbon-dioxide equivalent (CO₂e) produced throughout the life cycle (Fig. 5), or a climate impact equivalent to burning 15,491 mt (17,075 standard tons) of coal (<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>). A metric ton is equals 1.102 U.S. tons. Of that amount, 7,010 mt are attributable directly to poultry and egg growth; 8,740 mt to grain farming; 2,200 mt to oilseed (soybean) farming; 4,960 mt to electric power generation; and 1,330 mt to fertilizer manufacturing.

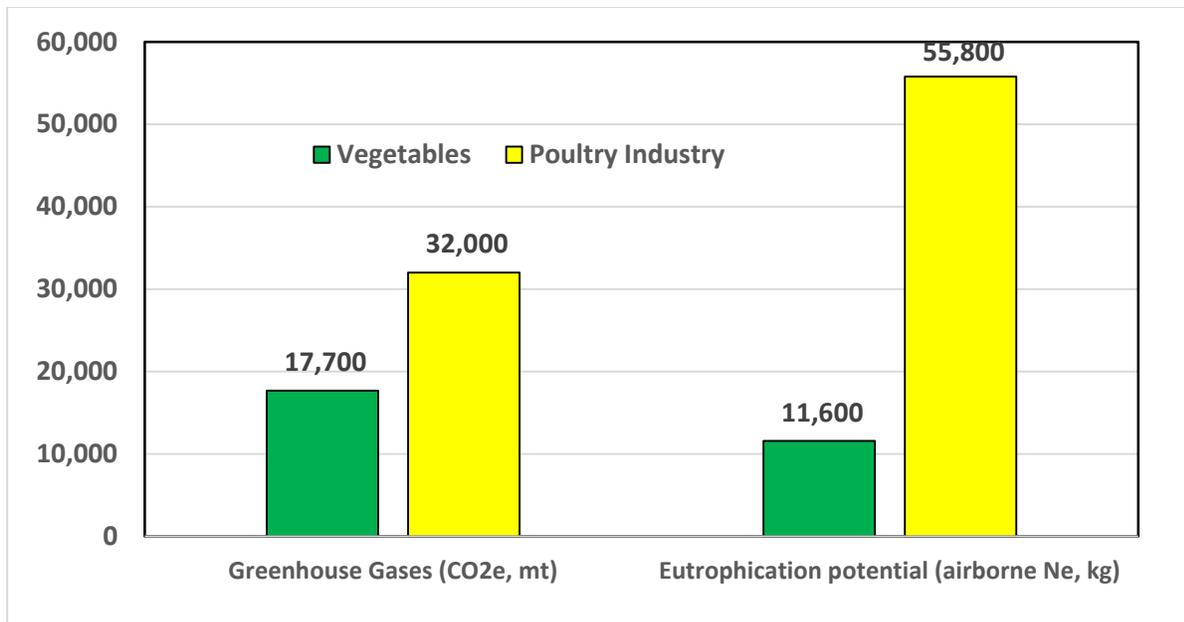


Figure 5: Relative environmental releases from a \$13,577,800 stimulus to vegetable farming, and to the poultry industry. For both greenhouse gases (expressed as carbon dioxide equivalents, in metric tons) and eutrophication potential (expressed in nitrogen equivalents, in kg), releases into the environment from the life cycle of poultry (and egg) products is significantly higher than for vegetables. Data represent a life-cycle analysis and are not local emissions.

By comparison, a \$13,558,700 production increase in vegetable and melon farming generates 44.7% fewer greenhouse gas emissions (Fig. 5): 17,700 metric tons (mt) of carbon-dioxide equivalent (CO2e) are produced throughout the supply chain and during growing. Of that amount, 6,780 mt are attributable directly to vegetable and melon farming. Another 4,670 mt is generated by electric power generation, which is very similar to the figure for poultry farming; and 1,980 mt are attributed to fertilizer manufacturing, which is higher than for poultry and egg farming. In both scenarios, much of the remaining CO2e is produced from transportation, chemical manufacturing, and fossil-fuel exploration, extraction, and refining.

THE IMPACT OF REGIONAL ENVIRONMENTAL CHANGE

On the Eastern Shore of Maryland, one primary climate impact will be sea-level rise: as global oceans warm, ocean water expands, and coastal communities experience that as rising sea level. A 2013 study led by the Maryland Climate Change Commission (http://ian.umces.edu/pdfs/ian_report_413.pdf) estimated that for Eastern Shore communities, sea level in 2050 will be 0.9 - 2.1 feet higher than in 2000; the “best estimate” derived by the MCCC is 1.4 feet above 2000 levels.⁸ By 2100, estimates range from 2.1- 5.7 feet, and the best estimate for 2100 is a 3.7-foot rise in sea level. It is important to note that these scenarios have been revised upwards in the past, and although they represent the latest available projections for Maryland, newer global predictions (*e.g.*, Hansen *et. al* 2016) make much higher predictions.⁹

The implications of sea-level rise are already evident in the Chesapeake Bay region. In developed regions of the watershed, sea-level rise is manifest as increased vulnerability to flooding, both periodically due to high tides and due to storm events. A recent report by the National Oceanographic and Atmospheric Administration¹⁰ quantified periodic inundation of urban communities nationwide; both Baltimore and Annapolis, MD led the survey, with an increase in so-called “nuisance flooding” of more than 920% since 1960. Annapolis now suffers flooding for 39.3 days each year, on average, and Baltimore more than 30. The economic consequences of regular inundation have not yet been determined, but are likely to be negative.

For rural areas of the Eastern Shore, periodic flooding remains a risk for waterfront cities and towns. However, the undeveloped, rural nature of the region dictates that the consequences will be shared by urban and rural stakeholders, including the agriculture community. Waterfront farms in the region are already seeing lost productivity due to storm surges and periodic flooding. No quantitative estimates of at-risk farmland are available at present, but a graphical representation of sea-level rise developed by

the Capital News Service (<http://cnsmaryland.org/sealevelrise>) anticipates coastal land losses across the state; for the Eastern Shore, losses appear heaviest in Dorchester, Somerset, and Wicomico Counties, towards the southern end of the region.

Other impacts on agriculture may be regional changes in temperature, rainfall and drought patterns. Regional predictions, summarized in the 2008 Maryland Climate Change Commission Comprehensive Assessment of Climate Change Impacts, are for higher temperatures and more intense, less frequent rainfall.¹¹ MCCC predicts that these changes will drive additional need for irrigation on Maryland's farms, thereby generating greater demand for groundwater resources and greater stress on the available supply of fresh water from aquifers in the state. As well, temperatures in the region are predicted to rise by 3°F by 2050, and perhaps as much as 9°F by 2100; this will create additional stresses for agriculture and will drive selection for new crop varieties that can be grown in the new climate conditions. The cost of mitigating these conditions will fall on farmers and will, most likely, result in stress on the farming community.

EUTROPHICATION POTENTIAL: RUNOFF OF EXCESS NUTRIENTS

For the Delmarva Peninsula, and in Maryland in particular, runoff from agriculture has a significant impact on regional water quality: excess nutrients and loose soil flow into the Chesapeake Bay, impairing water quality through eutrophication (buildup of surplus nutrients in the water column, consequent growth of algae and aquatic microorganisms, and subsequent loss of oxygen in the water). Eutrophication negatively affects occupations dependent on fisheries and recreation, many of which

have already been lost; it also has a negative impact on property value, thereby acting on those occupations, and those investment activities, that rely upon stable or growing property values.

A dramatic manifestation of eutrophication is the appearance of anoxic or hypoxic “dead zones” in the Chesapeake Bay, which are monitored and modeled by the National Oceanographic and Atmospheric Administration (NOAA). Agriculture, air pollution and wastewater treatment plant effluents all contribute to “dead zone” formation. In 2015, NOAA anticipated a dead zone of some 1.37 cubic miles, and noted that was an improvement – that it was 10% smaller than in prior years (<http://www.usgs.gov/newsroom/article.asp?ID=4254&from=rss#.VvrSLelrJD8>).

In the poultry industry, one contributor to waterborne pollution is the production of chicken litter: waste from barn-raised birds, combined with wood shavings or other absorptive material that is scattered on the floor of the barn. Poultry litter is high in both ammonia (a nitrogen-based compound) and phosphate. Ammonia is converted to nitrate by bacteria; both nitrate and phosphate are documented pollutants in the regional water table on the Delmarva Peninsula, and in the Chesapeake Bay. Poultry litter is an ongoing issue that industry regulators and civic organizations have tried to address and manage with varying degrees of success. According to the 2013 Agriculture in Maryland Summary, the Eastern Shore of Maryland is home to a revolving population of approximately 305,200,000 birds. Chastain, Camberato and Skewes (2001) estimate that 5-7.1 tons of litter is produced per animal unit (A/U) per year. One A/U is 1,000 chickens; indicating that the Eastern Shore produces nearly two million of tons of poultry litter a year.

Some poultry litter is a marketable commodity: many farms can legally use poultry litter as a fertilizer, except where soils are already saturated with phosphorus. The continued application of poultry litter as an amendment on already phosphorus-rich soils, sometimes referred to as hotspots, contributes to Chesapeake Bay eutrophication. For this reason, poultry litter application is managed via Maryland's Phosphorus Management Tool (PMT) regulation, which scales the use of poultry litter on a farm-by-farm basis. Unfortunately, the Maryland counties with the greatest numbers of chicken farming operations, and thus the greatest abundance of poultry litter, are also those areas with the highest soil concentrations of phosphorus, necessitating the transport of litter to other parts of the Eastern Shore, and the state.

EIOLCA does not deal with poultry litter directly, but instead returns estimates of an industrial sector's contributions to eutrophication, using methodology from the US Environmental Protection Agency's (EPA) Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI). TRACI estimates "eutrophication potential" -- the potential contribution to eutrophication -- from chemicals in the life cycle of a product. It does not report phosphorus data independently, but instead calculates the impact of phosphorus (and other nutrients) relative to that of nitrogen, and expresses that total estimated impact as kilograms of nitrogen equivalent (kg Ne) for both airborne and waterborne pollution.

The economic costs of eutrophication are typically reflected through three major avenues: waterfront property value, commercial fisheries, and recreation (including recreational angling). Generally, all three sectors are negatively impacted by increasing eutrophication: commercial fisheries decline, waterfront property values diminish, and on-the-water recreational activities are less when eutrophication rises. A

global review of the economic impacts of dead zones (Rabotyagov *et. al* 2014) found that oxygen levels in the Patuxent River, if reduced by 30%, resulted in a \$225,000 loss to the crab harvest in that waterway. In that review, the authors found that modeled impacts on recreational fisheries were mixed; catches of some species can rise, but lost revenue as recreational anglers relocate may be significant, and similar in scale to the commercial crab-harvest impact noted for the Patuxent River.¹²

Poultry production has a higher eutrophication impact than vegetable farming. In our model, \$13,558,700 of additional production in poultry and eggs is modeled to produce 55,800 kg Ne of airborne pollution (Fig. 5), and 26 kg Ne of waterborne pollution. Direct emissions from poultry and egg production are 45,400 kg Ne of airborne pollutants, and 6,550 kg Ne from associated grain farming. Both grain farming and poultry/egg production show far more airborne than waterborne nitrogen pollutants; the sector dominating waterborne Ne is animal food manufacturing.

Eutrophication predictions for vegetable and melon farming are far smaller (74.4% lower) than those for poultry and egg farming (Fig. 5), and they are also driven by airborne Ne. Of 11,600 kg Ne predicted from a \$13,558,700 increase in that sector, 9,760 kg Ne are predicted from direct vegetable and melon farming. Grain farming contributes only 205 kg Ne; power generation generates an additional 391 kg Ne. For this modeled change, waterborne Ne was dominated by fertilizer manufacturing (6.52 kg Ne).

At first blush, these predictions are surprising, because they apparently contradict data provided by nonprofits, NGOs, and government research laboratories around the Bay, which document waterborne nitrogen and phosphorus compounds as principal contributors to Chesapeake Bay eutrophication – data

which have withstood the rigorous peer review process that accompanies scientific publication in peer-reviewed journals. Some of this contradiction is due to the differences between life-cycle analysis and direct scientific measurement of contaminants. It is also important to recall that unlike the IMPLAN model used in this report, EIO/LCA projections are not regional, but global: nitrogen equivalents in this model, even those directly attributable to agriculture, are not localized to the Chesapeake Bay watershed but occur throughout the industry.

THE THREAT TO THE EASTERN SHORE'S NATURAL CAPITAL

While we recognize that all agricultural activities impact the environment, some practices more than others, we argue that disturbing less, and generating higher returns, are the goals for preserving and enabling soil and water resources to regenerate. Conventional farming, whether grain or vegetable farming, does not do this; but what our investigation does show is that they are far less damaging to land and water than all conventional poultry activities.

LAND AREA USED

Vegetable and melon farming is modeled to use significantly less land to generate \$13,558,700 than poultry and egg production (Fig. 6). Poultry production at this scale requires 29,146 acres, of which more than half is for grain farming; vegetable farming uses only 10,596 acres – a difference of 63.6%. This supports local data showing that vegetable farming is more profitable, the rate of return per acre is higher, than grain or poultry farming.

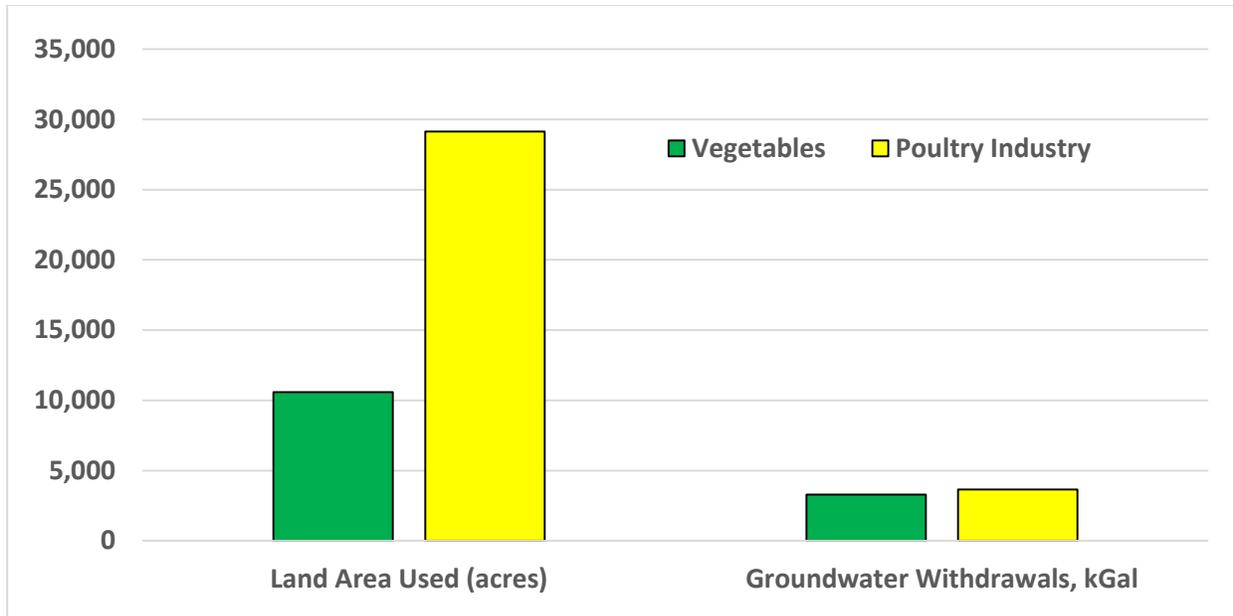


Figure 6: Resource use under two IMPLAN models. Assuming a \$13,577,800 stimulus to vegetable farming, and to poultry and egg production, the amount of land necessary to achieve that economic benefit is much greater for poultry than for vegetable farming. Groundwater withdrawals are similar between the two industries.

GROUNDWATER WITHDRAWALS

Groundwater withdrawals for poultry growth, meat processing, and crop irrigation are broadly similar for modeled \$13,588,700 increases in poultry farming and vegetable farming (Fig. 6). To support a \$13,558,700 increase in the poultry- and egg-production industry, EIO/LCA calculates 3,660,000 gallons of water withdrawn throughout the supply chain; 3,640,000 gallons go to grow the necessary grain (including irrigation and other water uses), and another 141,000 gallons are needed for electrical power generation. Vegetables and melons use slightly less water: 3,610,000 gallons in total, including 3,300,000 directly in vegetable and melon growth, and another 133,000 in power generation.

Opportunities exist for Delmarva agriculture to gain efficiency in water use. Drip irrigation is one option: it uses one-quarter to one-half as much water as spray irrigation (University of Florida IFAS Extension;

<http://edis.ifas.ufl.edu/hs388>). Incentives for drip irrigation installation may present a policy tool to help better manage water resources on the Eastern Shore and Delmarva.

Fortunately, alternatives exist for farmers who want to reduce their environmental impacts. Organic grain farming, particularly when coupled with no-till practices, offers farmers similar yields to “conventional” grain farming and serves as a carbon “sink” – rather than producing greenhouse gases, organic no-till practices actually remove CO₂ from the global atmosphere (Conant *et al.*, 2001 IN Rodale Institute, 2015. Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming). Organic plant-crop farming relies less on chemical fertilizer inputs, and has correspondingly fewer outputs of greenhouse gases and toxic chemical releases; organic poultry production raises fewer environmental consequences than confined-animal feeding operations, or “factory” farming. Further incentive is derived from the market price of organic goods like organic grain, which traded around at \$8.06/bushel as of 4/13/16, according to the USDA Livestock, Poultry and Grain Market News as compared to conventional corn trading a \$3.72/bushel, for May delivery, during the same time. Transitions to local, organic, sustainably farmed human foods, especially when compared to “conventional” monoculture grain and soybean agriculture to support large-scale intensive poultry growing, presents an enormous opportunity for environmental improvement.

Strengthening a Region: A Quest for Sustainability

The pursuit of local food systems development for rural communities is in response to a broad variety of unmet needs. Economic recovery since the official end of the Great Recession has bypassed the Eastern Shore. Exploring the benefits of scaled local food production is as much about increasing household and

regional income as it is about securing well-being, identity and sustainability. Regional agriculture is largely limited to one industry, at a cost. Poultry on the Eastern Shore region is dominated by four vertically integrated firms: Perdue in Salisbury, Maryland; Mountaire in Millsboro, Delaware; Allen Hakim that recently announced it will leave Cordova, Maryland to expand operations in Harbeson, Delaware; and Amick Farms in Hurlock, Maryland. With the Allen Hakim relocation, 300 jobs will be lost in Talbot County. From hatcheries to feed production to processing, the region's identity is synonymous with poultry, to the point where it has been called, by some, a company farm.

Yet contract poultry farming is not the agricultural legacy of the Eastern Shore; rather, its legacy is growing a diverse selection of food for regional markets. Comparing the 1940 to 2007 Census of Agriculture data, Food and Water Watch outlined the decades-long shift in production away from a diverse array of products: cattle, hogs, broiler chickens, vegetables, grain corn, wheat and orchard fruit. Just prior to America's entry into World War Two, fruit and vegetable crops made up more than a quarter of farm sales: 26.3 percent, according to the 1940 Census of Agriculture. "Farmers grew a variety of produce, often called 'truck crops', including sweet potatoes, tomatoes, green peppers, snap beans, lima beans, cucumbers, watermelons, sweet corn, cabbage, strawberries, and spinach" (The Cost of Economic Monopolies, 2012).¹³ These products were transported to New York City, Philadelphia, Trenton, Wilmington, Baltimore and Washington, D.C. It was estimated that farm sales on the Eastern Shore in 2007 could have been about \$137 million higher if the region cultivated the same proportion of land in vegetables, melons and strawberries as was cultivated before the rise of industrial poultry.^(ibid)

Without expanding regional wealth, public health will deteriorate and become a greater burden to the state. Supporting the Maryland Department of Health and Mental Hygiene guidelines, and the U.S.

Department of Health and Human Services' Dietary Guidelines for Americans, to improve nutritional intake should be a goal for regional governments, who bear the costs of poor public health. An aggressive start to that support would promote greater purchasing of fresh, locally grown food by Eastern Shore public school districts which may even support cognitive development and academic performance.¹⁴ Reducing the obesity rate and other diet-related illnesses reduces costs and strengthens the region's human and social capital. Increasing access to nutrient-dense food and reducing rising food insecurity, should start locally first and much of the impact it will have, rests on soil health and water quality.

According to the USDA, all the organic farmland in the U.S. would fit in an area the size of New Jersey; as of 2011 there were about 5,383,119 million acres in organic production that would make the Eastern Shore, which currently has about 1,011,322 acres of land in farms, a potentially significant organic food source should a percentage of existing or fallow land be brought into food production. The potential availability of land and its quality, given the connection between soil health and nutrient content, could be determined using GIS mapping tools. The Rodale Institute recently completed a thirty-year *Farm Systems Trial* which measured the performance of organic/regenerative agriculture alongside conventional practices. The findings of Pimentel *et al.*, underscore the need for, and the economic opportunities of, a shift from conventional monoculture, which is reliant on chemical inputs known to degrade soil health and water resources.¹⁵ In contrast, a sustainable polyculture restores soil health and values clean natural systems. Healthy soil contains minerals, micro-organisms and fungi, the absence of which produces food with fewer nutrients driving malnutrition. If a 1950 apple contained 4.3 mg of iron, but by 1998 it declined to 0.18 mg, as posited by Michael S. Locklear author of *A New Paradigm: Soil Centered, High-Yield Intensive, Nutrient Dense Farming*, to get the same level of iron an individual would

have to eat 24 1998 apples. An inverse relationship has been noted in the decrease of food-borne minerals like: iron, calcium, zinc, cobalt, magnesium, copper, selenium and phosphorous and the gradual increase in diseases like: cancer, obesity, heart conditions and bronchitis.¹⁶ Given the trend of valuing food based on freshness and nutrient content versus weight would indicate that activities which diminishing soil health and nutrient content could have a negative market value impact. Regenerative agricultural practices focus on reversing soil depletion and improving environmental sustainability by restoring loss mineral and rebuilding organic matter content without synthetic chemical inputs. A comparative analysis of the triple-bottom-line impacts between: conventional, organic and regenerative practices in the region would be a useful extension of this investigation.

For those who believe the Eastern Shore has a stronger role to play in the Mid-Atlantic region, the preliminary results of this report are encouraging, but more primary source data collection in targeted study areas are need to fine-tune scope and accuracy.¹⁷ Strengthening the economy, society and environment of the nine-county region starts by recognizing its unique natural capital, and targeting market-driven activities that lead to expanded well-being. Our globalized food system needs to be complemented with local solutions which address regional needs. Many communities recognize the economic, social and environmental opportunity this presents and are taking leadership in shaping their food system. The appearance of local and organic food in discount superstores, like Wal-Mart and Costco, signals that broader segments of the population value these products that were initially marketed as luxury goods.

From state and county-level economic development directors to business sectors supporting agriculture, local food system development offers rural communities a rare commercial opportunity that can help

restore higher levels of regional income and social investment lost over the decades. Simply more of the same, expanding current industry with more CAFOs, is not going to solve the Eastern Shore's triple-bottom-line challenges any more than relying on a post recession recovery did.

Sustainable change will need to come from the community level. Food hub proponents, local food system stakeholders including regional economic development officials, environmentalists and public health leaders now have access to our impact assessment work which presents a new perspective on food production's regional value. This information can and should be used to shift and drive the dialog deeper as more local data is acquired. With additional spending pattern data more scenarios will be run. The EIO/LCA tool running 2002 data is too old and generalized to make accurate local assumptions about GHG emissions and other effluent discharges. A new tool will have to be developed to be more useful to this region.

The Eastern Shore needs, and has the capacity to support, a broader product mix of commodities. Stressed communities like Millington (Maryland) once showed signs of stability as indicated by the architecture and number of theatres or opera houses, which have long been abandoned or informally repurposed. These visual reminders not only should trigger questions, but offer hope. The objective of this report is to stimulate a deeper, open discussion around the growth plan for the region. Everyone, especially economic development directors, want to bring jobs to their respective communities and admits that residents are their strongest asset, but little will change unless the region is positioned strategically with a sound market-based, value proposition. This is not about selling what is in inventory, but developing new products. As such, a certain level of resistance may be encountered. Identifying Eastern Shore and Delmarva local food systems "warriors, weavers and builders" will be necessary to

implement an effective communication plan via a network of supportive stakeholders, at all levels.¹⁸ Like any campaign, tools and expertise are needed to gauge sentiment and the priorities of average residents on the Eastern Shore to better identify their aspirations and fears are before a roadmap to a more prosperous destination can be drafted.

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Eastern Shore Agriculture *Sustains* (ESAS) is the Delmarva Peninsula's only consultancy using a triple-bottom-line approach, comprehensively, assessing regional: economic, social and environmental impacts in the fourteen county, tri-state region. As a partner, ESAS works with nonprofits and social enterprises looking to articulate their value proposition quantitatively to a variety of current or prospective stakeholders. With over fifty years of experience in a wide range of disciplines from marketing financial derivatives, economics, environmental science, copywriting, and education, our eclectic background enhances our client's data-driven narrative with a focus on measuring relevant impacts which will strengthen their region.

Chesapeake College was founded in 1965 as Maryland's first regional community college, Chesapeake serves five Eastern Shore counties – Caroline, Dorchester, Kent, Queen Anne's and Talbot. With more than 130,000 alumnae, Chesapeake has 2,300 students and almost 10,000 people enrolled in continuing education programs.

The Chesapeake College Center for Leadership in Environmental Education (CLEEn) is a multidisciplinary institute that spearheads the College's sustainability programming. Its mission includes education, community leadership, and campus planning. Since its inception in 2010, CLEEn has designed educational experiences in both credit and non-credit courses; on-campus renewable energy and energy savings programs; and campus storm-water remediation; community efforts have included leadership in food security, resiliency, and renewable energy.

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